COMBINED HEAT AND POWER CHALLENGE

ROLE OF TECHNOLOGIES IN CHP SYSTEMS

Technology Innovation Renews Interest in CHP

Recent developments are generating renewed interest among government and private sector professionals in combined heat and power (CHP) systems. Many CHP technologies, such as boilers and steam turbines, have been used in CHP applications for decades. Research and development advances continue to result in improved performance and reduced cost for these applications.

Interest in the potential for CHP has been further heightened by the introduction of new technologies that have greatly expanded the range of cost effective CHP applications. These technologies include new prime movers, such as advanced combustion turbines and fuel cells, as well as enabling technologies including advanced system control equipment and improved materials that can withstand high temperatures and corrosion. The result is an impressive suite of competitive CHP technologies available in today's marketplace to meet the power and heating needs of a wide variety of end users.

CHP Technologies

- **Boilers** convert thermal energy in hot gas from the combustion of a wide range of fuels or waste heat from industrial processes into steam or hot water. They span a wide range of sizes and are often used with by-product fuels such as biomass or refining crudes. Recent developments include improved tubing material with increased durability and modular designs that require less operating expertise.

- **Steam turbines** convert steam energy from a boiler or waste heat into shaft power. In a CHP system they provide the power while in a combined cycle configuration they supplement the power output from another prime-mover in the system, such as a combustion turbine. Recent advances have resulted in lower costs and improved reliability and efficiency. Steam turbines are now available in smaller sizes (less than 50 kW). New turnkey boiler/steam turbine CHP designs offer low maintenance modular expansion capability.

- **Combustion turbines** use heat to move turbine blades that produce electricity. Design experience has increased the efficiency and reliability of turbines, while reducing cost and emissions. Advances in power electronics have enabled simpler designs with reduced operating costs and improved efficiency. While simple cycle CTs have been overtaken by combined cycle CTs for electricity generation, new advanced simple cycle turbine systems (40% electric efficiency for 3 MW system)

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could mean that they become a leading prime mover for industrial-sized CHP systems. Microturbines (30-250kW) are emerging as a CHP technology for commercial buildings.

- **Spark ignition engines** are the fastest growing prime mover for small (1-10 MW) CHP systems in which heat is recovered in a boiler. Their reciprocating shaft power can either produce electricity through a generator or drive loads directly. Spark engines can now operate on a wide range of liquid and gaseous fuels, including natural gas and gasoline. These engines may require more routine maintenance than comparably-sized turbines but their reliability is comparable. Spark engines have outsold turbines 18 to 1 in the 1 to 5 MW size range due in large part to reductions in cost and improvements in reliability. Between 1992 and 1998, sales of gas engines grew more than 200%, to more than 7 GW.

- **Diesel engines** or compression-ignition reciprocating engines are the leading prime mover for very small (less than 1 MW) CHP systems, especially for emergency and backup power. Like gas engines, they produce shaft power for electricity or direct drive and recover heat in a boiler. Recent advances in computerized design techniques and the use of advanced materials have improved the reliability and efficiency of diesel engines while reducing emissions.

- **Fuel cells** produce an electric current and heat from chemical reactions rather than combustion. There are currently four fuel cell types under development, each using a different electrolyte. Despite their higher cost, fuel cells' negligible air emissions, very high efficiency and low maintenance make them attractive for many niche applications. Fuel cells do, however, have greater sensitivity to fuel impurities than the combustion-based systems. Recent commercialization efforts have been driven largely by research on fuel cells for automotive applications. These efforts have reduced the cost and improved the performance of fuel cells dramatically.

- **Absorption Chillers** can use waste heat from CHP systems to produce chilled water. This application makes it possible to shift an electric load to a thermal load, allowing for continuing use of CHP systems during the cooling season. Recent developments in double and triple-effect absorption chillers have dramatically improved their efficiency, safety and reliability and lowered their cost.

- **Engine-driven chillers** operate compressors directly for refrigeration with a turbine or reciprocating engine. Heat is also recovered from the engine in a boiler. This method is more efficient than using an electric motor because it limits the losses associated with generating electricity and then producing shaft power for the compressor. Recent improvements in sensors and controls have enabled lower cost, smaller, packaged systems.

- **Gasification** converts a solid or liquid fuel into a gaseous form that can be used in advanced engine and turbine designs. Modern gasification systems incorporate cleaning subsystems that can remove pollutants prior to combustion. This technology expands the range of possible fuels that can be used by new CHP systems. Possible fuel inputs include biomass, coal and a number of waste materials. Recent developments in design, materials and controls have lowered the cost and improved the reliability and quality of the gas produced by gasification.

CHP CHALLENGE

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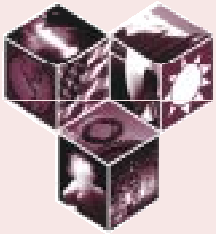

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